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Dividends From Wood Research

Recent Publications
July–December 1995

Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer between July 1 and December 31, 1995.

Each publication listed in this brochure is available through at least one of the following sources.

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the order number on the blank at the end of the brochure and mail or FAX the blank to FPL.

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List of Categories

Publications are listed in this brochure within the following general categories:

Anatomy and Identification
Biodeterioration and Protection
Engineering Properties and Design Criteria
Fiber and Particle Products
Fire Safety
Microbial and Biochemical Technology
Processing of Wood Products
Pulp, Paper, and Packaging
Timber Demand and Technology Assessment
Tropical Wood Utilization
Wood Bonding Systems
Special Item

Anatomy and Identification

1. Hardwoods of North America

Alden, Harry A.
1995. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–83. 136 p.
This report describes 53 taxa of hardwoods of North America. Descriptions include scientific name, trade name, distribution, tree characteristics, wood characteristics (general, weight, mechanical properties, drying, shrinkage, working properties, durability, preservation, toxicity and uses) and additional sources for information.

Biodeterioration and Protection

Proceedings of the International Research Group of Wood Preservation; 26th annual meeting; 1995 June 11–16; Helsingor, Denmark. The Research Group on Wood Preservation

Available from IRG Secretariat, Box 5607, S–1114 86 Stockholm, Sweden.
Cost: about 150 Swedish crowns/item.

Current and Future Options for Managing Used Preservative-Treated Wood by De Groot, Rodney C.; Felton, Colin. Document IRG/ 95–50042.

Natural Progression of Decay in unrestrained, Southern Pine Sapwood Lumber Exposed Above Ground by De Groot, Rodney, C.; Ross, Robert J.; Nelson, William. Document IRG/WP 95–20060.

The Long Road to Understanding Brown-Rot Decay—A View From the Ditch by Green, Frederick, III; Highley, Terry L. Document IRG/WP 95–10101.

Antagonism of *Gliocladium virens* Against Wood Decay Fungi by Highley, Terry L.; Ferge, Les. IRG/WP 95–10102.

Movement of Boron From Fused Boron Rods Implanted in Southern Pine, Douglas Fir, Red Oak, and White Oak Timbers by Highley, Terry L.; Ferge, Les. IRG/WP/95–30061.

Trails of New Treatments for Prevention of Kiln Brownstain of White Pine (*Pinus Strobus*) by Schmidt, E.; Christopherson, E.; Highley, T.; Freeman, M. IRG/WP 95–30068.

2. Extracellular Polysaccharide-Degrading Enzymes of *Postia Placenta* Isolated From Wood or Artificial Media

Clausen, C.A.; Green, F. III; Highley, T.L.
1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 231–242.

The extracellular polysaccharidases and the role of the glucan sheath were the focus of this study. The objectives were (1) to analyze differences in enzyme production, glucan composition, and antibody recognition and (2) to determine the differences in brown-rot decay organisms grown on wood as opposed to artificial growth medium.

3. Performance of Preservative-Treated Wood Shingles and Shakes

De Groot, Rodney

1995. In: Science and technology: The basis for improved roofing: Proceedings of the 11th conference on roofing technology; 1995 September 21–22; Gaithersburg, MD. Rosemont, IL: National Roofing Contractors Association: 22–30.

Preservative treatments can be applied to wood roofing before or after installation. This paper briefly reviews treatment objectives, types of treatments, treating standards, quality control, technical factors that affect shake and shingle performance, environmental concerns, and disposal of spent or excess-treated wood products. A synopsis of research on alternative treatments for wood shakes and shingles being conducted at the USDA Forest Service, Forest Products Laboratory, is also presented.

4. Performance and Durability of Finishes on Previously Coated CCA-Treated Wood

Feist, William C.; Ross, Alan S.

1995. Forest Prod. J. 45(9): 29–36.

The objective of the work reported here was to evaluate the performance of a variety of surface finishes applied over previously finished and exposed wood that was either untreated or treated with chromated copper arsenate (CCA). This information is important because wood pressure treated with CCA is widely used in architectural projects, such as decks, walkways, gazebos, marine structures, and retaining walls.

5. Chemical Changes in Wood Components and Cotton Cellulose as a Result of Brown Rot: Is Fenton Chemistry Involved?

Flournoy, Douglas S.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 257–293.

Brown-rot fungi seem to utilize an entirely different mechanism to degrade cellulose than do other cellulolytic organisms. The prevailing hypothesis implicates low molecular weight transition metal chelates, which act in two possible ways: (1) through biochemical conversion into potent oxidizing species or (2) through participation in the biochemical generation of an activated oxygen species, in close juxtaposition to the cellulose. This review is a critical examination of this hypothesis.

6. Induction of Polygalacturonase and the Formation of Oxalic Acid by Pectin in Brown-Rot Fungi

Green, F., III.; Clausen, C.A.; Kuster, T.A.; Highley, T.L.

1995. World J. of Microb. & Biotech. 11: 519–524.

The objective of the present study was to survey polygalacturonase activity in three taxonomically diverse brown-rot Basidiomycetes grown in liquid culture. In addition, degradation of the bordered pits in wood blocks decayed by *P. placenta* was studied by transmission electron microscopy.

7. Comparison of Wood Preservatives in Stake Tests—1995 Progress Report

Gutzmer, D.I.; Crawford, D.M., comps.

1995. USDA Forest Serv. Res. Note FPL–RN–02. 124 p.

This report covers stake test results primarily from Southern Pine 2- by 4- by 18-in. sapwood, treated by pressure and nonpressure processes, and installed in decay and termite exposure sites at various times since 1938 at Saucier, Mississippi; Madison, Wisconsin; Bogalusa, Louisiana; Lake Charles, Louisiana; Jacksonville, Florida; and the Canal Zone, Panama. Also included in the tests at Saucier, Mississippi, are smaller pine stakes and those of treated and untreated plywood, particleboard, modified woods, laminated paper plastic, pine infected with *Trichoderma* mold, plus other selected wood species such as oak, Douglas-fir, and Engelmann spruce.

8. Above-Ground Performance of Surface-Treated Hardwoods and Softwoods

Highley, T.L.

1993. Wood Protection. 2(2): 61–66.

The objective of this study was to evaluate alternatives to chlorinated phenols to control decay in surface-treated hardwood and softwood species exposed above ground. This paper reports the results of brush-treated units after 5 to 12 years of above-ground exposure at the USDA Forest Service national exposure sites near Gulfport, Mississippi, and Madison, Wisconsin.

9. Colonization and Control of Decay by *Trichoderma* in Douglas-Fir and Southern Pine Exposed Above Ground

Highley, Terry L.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 295–305.

The objective of this study was to determine the ability of Binab-T pellets and wettable powder to colonize and prevent decay in Douglas-fir and Southern Pine above ground.

10. Processes of Wood Decay and Deterioration

Highley, Terry L.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 227–230.

The research reported in this chapter discusses several aspects of fungal deterioration of wood, which should aid in the development of safer wood preservation methods.

11. *In Vitro* Effect of Isatin on Wood Decay Fungi

Illman, Barbara L.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 307–315.

This paper reports the effects of isatin on white- and brown-rot wood decay fungi *in vitro* and discusses the relevance of the effects to fungal metabolism.

12. Chemical Composition and Fungitoxic Activities of Pine Cone Extractives

Micales, J.A.; Han, J.S.; Davis, J.L.; Young, R.A.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 317–332.

This paper reports on a project that was designed to study the chemical composition of pine cones and to determine whether cones from four different *Pinus* species contain extractives active against the fungi that cause mold, sapstain, and wood decay.

13. Distribution of Polyphenol Oxidase in Organelles of Hyphae of the Wood-Deteriorating Fungus, *Coriolus Versicolor*

Moore, Nina L.; Brako, L.A.; Clausen, C.A.; Jones, B.R.; Dashek, W.V.

1994. In: Llewellyn, G.C.; Dashek, W.V.; O'Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 333–356.

Results are reported from a combined biochemical and electron microscopical approach to delineate polyphenol oxidase's (PPO's) subcellular route of secretion culminating with regulating its appearance in the external milieu. Concomitant with these investigations are studies employing

substrate induction and recombinant DNA technologies to yield PPO over-production.

14. Influence of Lignin Type on the Decay of Woody Angiosperms by *Trametes Versicolor*

Obst, John R.; Highley, Terry L.; Miller, Regis B. 1994. In: Llewellyn, G.C.; Dashek, W.V.; O Rear, C.E., eds. Biodeterioration research 4: Mycotoxins, wood decay, plant stress, biocorrosion, and general biodeterioration: Proceedings of 4th meeting of the Pan American Biodeterioration Society; 1991 August 20–25; as an electronic symposium. New York: Plenum Press: 357–374.

The generally observed pattern of decay resistance in woody angiosperms can be correlated with the guaiacyl-rich lignin regions in white birch. However, it was reported that *Trametes versicolor*, a nonselective white-rot fungus, severely degraded the middle lamella and cell corners of sweetgum without significant degradation of adjacent cell walls. This study reexamines this finding and extends the investigation to describe the decay of vessels and rays as well as fibers.

15. The Effect of Surface Roughness on the Performance of Finishes. Part 1. Roughness Characterization and Stain Performance

Richter, Klaus; Feist, William C.; Knaebe, Mark T. 1995. Forest Prod. J. 45(7/8): 91–97.

The purpose of this investigation was to determine how the roughness of wood surfaces affects the overall performance of different coatings. This paper presents the results of surface characterization (roughness measurement and interpretation of roughness and roughness standards) and the performance of stained samples in accelerated weathering. Subsequent papers will discuss the relation of roughness and paint adhesion and the performance of painted and stained samples exposed outdoors.

16. Thinking Ahead—Research at Forest Products Lab Sets Sights on the Year 2000

Williams, R. Sam 1994. American Paint & Coatings Journal Convention Daily. 79(11): 29–30.

Wood finishing research at the Forest Products Laboratory (FPL) in Madison, Wisconsin, began about 1920, and a program has been continuously maintained since that time. Much of the knowledge on moisture, species, and weathering effects with regard to finishing was discovered through work at the FPL. Recently, a new 5-year program in wood surface chemistry was approved. The description of this program is the subject of this article.

Engineering Properties and Design Criteria

17. Manufactured Housing Walls That Provide Satisfactory Moisture Performance In All Climates

Burch, Douglas M.; TenWolde, Anton 1995. In: Mitchell, J.W.; Beckman, W.A., eds. Building simulation '95: Proceedings of 4th International conference; International Building Performance Simulation Association; 1995 August 14–16; Madison, WI. IBPSA: 22–33.

In this report, the MOIST computer model was used first to investigate the moisture performance of a current-practice wall construction and subsequently to investigate the performance of two alternative walls, which have the potential for satisfactory moisture performance in all climates of the United States. A one-dimensional model, such as MOIST, can only provide approximate average moisture performance for actual three-dimensional constructions. However, it is appropriate to use such models to compare the performance of alternative constructions and use the results to assess the expected effectiveness of changes in design.

18. Performance of Glued-Laminated Timber Beams of European Manufacture

Falk, Robert H.; Hernandez, Roland 1995. Forest Prod. J. 45(7/8): 27–34.

The basic objective of this research was to characterize the performance of glulam timber beams manufactured in Norway from Norwegian spruce (European Whitewood) relative to the developing CEN standards. This

study was also an opportunity to collect data for evaluating these European beams using American design methods, an important link in comparing the performance of U.S. glulam beams to their European counterparts.

19. Design and Evaluation of Two Bridge Railings for Low-Volume Roads

Faller, Ronald K.; Rosson, Barry T.; Sicking, Dean L. 1995. In: Proceedings of 6th International conference on low-volume roads; 1995 June 25–29; Minneapolis, MN. Washington, DC: National Academy Press: 357–372. Vol. 2.

The objective of this research project was to develop two low-cost bridge railing systems for use on longitudinal timber bridge decks with low traffic volumes and speeds. A longitudinal glulam timber deck was selected for use in the development of the bridge railings because it is the weakest type of longitudinal timber deck for resisting transverse railing loads currently in use. Thus, any bridge railing not damaging the longitudinal glulam deck could be easily adapted to other, stronger, timber deck systems.

20. Moisture Content and the Flexural Properties of Lumber: Species Differences

Green, David W.; Evans, James W.; Pellerin, Roy 1991. In: Proceedings of the 1991 International timber engineering conference; 1991 September 2–5; London, UK. TRADA: 2.181–2.188. Vol. 2.

The objective of this study was to present the results on the effect of change in moisture content on the bending properties of lumber for five species. This study is limited to standard 38- by 89-mm (nominal 2- by 4-in.) lumber of two grades. A future paper will evaluate the applicability of analytical models recently adopted in engineering design standards to these species.

21. Western Hardwoods: Value-Added Research and Demonstration Program

Green David; von Segen, William; Willits, Susan, eds. 1995. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–85. 43 p.

Research results from the value-added research and demonstration program for western hardwoods are summarized in this report. The intent of the program was to enhance the economy of the Pacific Northwest by helping local communities and forest industries produce wood products more efficiently. Emphasis was given to value-added products and barriers to increased utilization.

22. Mechanical Properties for Lumber of Dahurian Larch

Gupta, Rakesh; Ethington, Robert L.; Green, David W. 1994. In: Fridley, K.J.; Dolan, J.D., eds. Systems approach to wood structures. Proceedings of the Wood Engineering Division sessions at the 1993 annual meeting of the Forest Products Society; 1993 June 20–23; Clearwater Beach, FL. Proceedings 7312. Madison, WI: Forest Products Society: 68–71.

The purpose of this study was to develop a process that could be used by an American Lumber Standards grading agency to seek approval for assigning allowable properties to machine stress rating lumber produced from a foreign species. This paper describes the study and the tests in progress on Dahurian larch (*Larix dahurica*).

23. Fiber Stress Values for Design of Glulam Timber Utility Structures

Hernandez, Roland; Moody, Russell C.; Falk, Robert H. 1995. USDA Forest Serv. Res. Pap. FPL–RP–532.

The objective of this research was to develop a method for determining fiber stress values for glulam timber to be included in ANSI 05.2. These fiber stress values must be developed on a similar basis to those found in ANSI 05.1 to provide equal reliability for glulam timber used in utility structures.

24. Fundamentals of Hand Held Moisture Meters: An Outline

James, William L. 1994. In: Proceedings of ASTM hand-held moisture meter workshop; 1993 May 5; Madison, WI. Madison, WI: Forest Products Society: 13–16.

In outline form, this paper gives the advantages and disadvantages of resistance and dielectric types of hand-held moisture meters.

25. Efficient Utilization of Red Maple Lumber in Glued-Laminated Timber Beams

Janowiak, John J.; Manbeck, Harvey B.; Hernandez, Roland; Moody, Russell C.; Blankenhorn, Paul R.; Labosky, Peter 1995. USDA Forest Serv. Res. Pap. FPL-RP-541.

In this study, two objectives were addressed to examine several aspects of red maple glulam product performance using low grade and small nominal-sized lumber processed from resawn cants. The first objective was to develop a glulam beam configuration using No. 3 grade lumber for 50 percent of the inner laminations that would achieve a design bending stress of 2,400 lb/in² and a design bending MOE of 1.8×10^6 lb/in² (24F-1.8E). The second objective focused on determining bending strength, shear strength, and bending stiffness properties of glulam beams made with No. 2 grade laminations having unglued nominal 2 by 4's and 2 by 6's laid edge-to-edge.

26. Effect of Varying Dimensions on Tapered End-Notched Flexure Shear Specimen

Kretschmann, D.E.

1995. Wood Sci. Technol. 29: 287-293.

This study evaluated the effect of varying dimensions on the performance of the proposed TENF shear specimen. Two variants were made: all dimensions were multiplied by 0.7 or 1.5, and only the thickness was changed by a factor of 0.7 or 1.5. The test matrix was a cross design with three sizes and three thicknesses.

27. Standard Plans for Southern Pine Bridges

Lee, Paula D. Hilbrich; Ritter, Michael A.; Triche, Michael 1995. USDA Forest Serv. Gen. Tech. Rep. FPL-GTR-84. 26 p.

The bridge plans presented in this publication are the first step in developing standardized designs for the Southern United States where Southern Pine is the primary structural wood species group. The plans include standardized sawn lumber bridges, stress-laminated glued laminated timber (glulam) bridges, and longitudinal sawn lumber stringer bridges with transverse plank decks. The plans are intended to serve as a useful guide to state, county, and local highway departments in the development of practical and economical bridge designs using Southern pine lumber and glulam. They should be particularly valuable to smaller highway departments with limited engineering staff.

28. Live Oak and White Oak Decay

McDonald, Kent A

1994. In: Technical aspects of maintaining, repairing, preserving historically significant ships: Proceedings of conference; 1994 September 12-14; Charlestown, MA. Washington, DC: Naval Historical Center: 312-316.

This study supports the general knowledge that live oak is very resistant to decay, and white oak is not as resistant to decay. Both species, when used, still need to be provided the maximum protection from moisture for them to perform as long as possible. This can be accomplished by careful construction practices and the use of protective finishes such as water repellent preservatives.

29. Timber Connection Design in the U.S. Converting to LRFD Format

McLain, T.E.; Soltis, L.A.; Pollock, D.G. Jr.; Pellicane, P.J. 1991. In: Proceedings of the 1991 International timber engineering conference; 1991 September 2-5; London, UK. TRADA: 2.277-2.285.

A U.S. wood industry-sponsored cooperative program has produced a proposed Load and Resistance Factor (LRFD) specification for engineered wood construction. The connections design provisions are, in part, a calibration of allowable stress design procedures. Major changes, however, are driven by conversion to a yield-model base from an empirical base for laterally-loaded connections with dowel-type fasteners. New provisions for axial withdrawal of driven and turned fasteners as well as interaction equations are proposed. Substantial improvements in code clarification, simplification and structure are incorporated in the LRFD document. A clear mechanism for including new materials in connection design is provided. This paper provides an overview of the proposed design criteria for connections and identifies sources of possible change from current practice.

30. Load and Resistance Factor Design Code for Wood Bridges

Nowak, Andrzej S.; Ritter, Michael A.

1995. In: Proceedings of 4th International bridge engineering conference; 1995 August 28-30; San Francisco, CA. Washington, DC: National Academy Press: 351-357. Vol. 2.

This paper summarizes selected provisions of the new AASHTO load and resistance factor design specifications as they relate to the design of wood bridges. These provisions include topics related to general design features, loads and load distribution, and wood design.

31. State of the Art Report: Glulam Timber Bridge Design in the U.S.

Ritter, M.A.; Williamson, T.G.

1995. In: Proceedings of 27th meeting of international council for building research studies and documentation, working commission W18—timber structures; 1994 July 7-8; Sydney, Australia. Germany: Universitat Karlsruhe. 10 p.

This paper briefly describes the evolution of modern glulam bridge design in the United States, including the development of vertically laminated deck systems, the use of alternative species for glulam manufacture, the introduction of technology for glulam stress-laminated decks and T and box sections, and the development of crash-tested timber guardrail systems.

32. Plans for Crash-Tested Bridge Railings for Longitudinal Wood Decks

Ritter, Michael A.; Faller, Ronald K.; Lee, Paula D. Hilbrich; Rosson, Barry T.; Duwadi, Sheila Rimal.

1995. USDA Forest Service Gen. Tech. Rep. FPL-GTR-87. 27 p.

In the past decade, bridge railing design criteria have moved away from static-load design and have focused on full-scale crash testing as a more appropriate and reliable means of evaluating bridge railings. The five bridge railing plans presented in this paper reflect the results of a cooperative research project. The project objective was to develop and crash test bridge railings and approach railing transitions for longitudinal wood bridge decks. Full drawing sets are provided in customary U.S. and SI units of measure. The testing procedure, results, and drawings have been approved by the Federal Highway Administration Federal-Aid and Design Office for use on Federal-aid highway projects.

33. Field Performance of Stress-Laminated Timber Bridges on Low-Volume Roads

Ritter, Michael A.; Wacker, James P.; Duwadi, Sheila Rimal

1995. In: Proceedings of the 6th International conference on low-volume roads; 1995 June 25-29; Minneapolis, MN. Washington, DC: National Academy Press: 347-356. Vol. 2.

This paper presents monitoring results for stress-laminated bridges that have been continuously monitored for 2 years or more. Included are observations and discussions related to bridge construction, moisture content, stressing-bar force, thermal response, vertical creep, load test behavior, and condition evaluation.

34. Design, Construction, and Evaluation of Timber Bridge Constructed of Cottonwood Lumber

Ritter, Michael A.; Wacker, James P.; Tice Everett D.

1995. In: Proceedings of 4th International bridge engineering conference; 1995 August 28-30; San Francisco, CA. Washington, DC: National Academy Press: 358-370. Vol. 2.

This paper describes the development, design, construction, and field performance of the Cooper Creek bridge located in Appanoose County, Iowa. The bridge is a two-lane, two-span, continuous stress-laminated deck with a length of 12.8 m. The bridge is unique in that it is one of the first known applications that utilizes Eastern Cottonwood lumber in a stress-laminated deck superstructure.

35. Dynamic Response of Stress-Laminated-Deck Bridges

Ritter, M.A.; Wood, D.L.; Wipf, T.J.; Duwadi, S.R.

1995. In Proceedings of 4th International bridge engineering conference; 1995 August 28-30; San Francisco, CA. Washington, DC: National Academy Press: 381-394. Vol. 2.

The objective of the research presented here was to determine the dynamic performance characteristics of three stress-laminated timber bridges. The results for these bridges will be combined with results from additional tests still to be performed and complementary analytical research to prepare design criteria to be submitted to AASHTO for inclusion in the *Standard Specification for Highway Bridges*.

36. Mechanical Properties of Guatemalan Pine 2 by 4's

Rosales, Augusto; Morales, Gabriel ; Green, David
1995. *Forest Prod. J.* 45(10): 81–84.

The objectives of this study were to summarize the results of flexural tests conducted on full-size specimens and compare the results with mechanical property values of similar U.S. species.

37. Bolted Connection Research: Present and Future

Soltis, Lawrence A.
1994. *Wood Design Focus.* 5(2): 3–5.

In 1991, the design practice for bolted connections in the United States was changed from an empirical basis to the yield theory, a design practice that is used in many other countries. It has been determined that the yield theory adequately describes single-bolt connections. However, because multiple-bolt connections are not well understood, current design practices would benefit from additional research. This paper identifies some specific research needs.

38. Portable Glulam Timber Bridge Design for Low-Volume Forest Roads

Taylor, S.E.; Keliher, K.P.; Thompson, J.D.; Ritter, M.A.; Murphy, G.L.
1995. *In: Proceedings of the 6th International conference on low-volume roads*; 1995 June 25–29; Minneapolis, MN. Washington, DC: National Academy Press: 328–338. Vol. 2.

Many advantages of timber bridges, which include using locally available materials, having long service lives, being relatively lightweight and easy to fabricate, and being prefabricated, make them ideal for temporary stream crossings. The objectives of this paper are to discuss design criteria for portable bridges and review the design and performance of a portable longitudinal glued-laminated (glulam) deck timber bridge.

39. Airflows and Moisture Conditions in Walls of Manufactured Homes

TenWolde, Anton; Carll, Charles; Malinauskas, Vyto
1995. *In: Modera, Mark P.; Persily, Andrew K., eds. Airflow performance of building envelopes, components, and systems: Proceedings of symposium*; 1993 October 10–11; Dallas/Fort Worth Airport, TX. STP 1255. Philadelphia, PA: American Society for Testing and Materials: 137–155.

The purpose of this study were to (1) quantify air leakage characteristics of walls representative of walls of manufactured homes in the United States, (2) identify the relationship between airflows and moisture accumulation in these walls in a northern U.S. climate, (3) identify the influence of wall construction details on air leakage and moisture accumulation, and (4) identify the role of indoor relative humidity on moisture accumulation in walls.

40. Field Performance of Timber Bridges—4. Graves Crossing Stress-Laminated Deck Bridge

Wacker, James P.; Ritter, Michael A.
1995. *USDA Forest Serv. Res. Pap. FPL–RP–539.* 17 p.

The Graves Crossing bridge was constructed October 1991 in Antrim County, Michigan, as part of the demonstration timber bridge program sponsored by the USDA Forest Service. The bridge is a two-span continuous, stress-laminated deck superstructure that is 36-ft long and 26-ft wide. The bridge is one of the first stress-laminated deck bridges to be built of sawn lumber treated with chromated-copper-arsenate preservative. Based on 2 years of field observations, the bridge is performing well with no structural or serviceability deficiencies.

41. Wood Properties

Winandy, Jerrold E.
1994. *In: Arntzen, Charles J., ed. Encyclopedia of Agricultural Science.* Orlando, FL: Academic Press: 549–461. Vol. 4.

This encyclopedia section discusses the properties of wood. In particular, the material covers wood structures, physical and mechanical properties of wood, and properties and grades of sawn lumber.

42. Influence of Short-Term Load Duration and Moisture Content on the Strength of CCA-Treated Lumber

Winandy, J.E.
1994. *In: Fridley, Kenneth J.; Dolan, J.D., eds. Systems approach to wood structures. Proceedings of the Wood Engineering Division sessions at the 1993 annual meeting of the Forest Products Society*; 1993 June 20–23; Clearwater Beach, FL. *Proceedings* 7312. Madison, WI: Forest Products Society: 97–99.

Previous studies on the effects of preservative treatments on allowable design stresses have evaluated only the effects of CCA treatment at load durations of 60 to 200 s and at 12 percent moisture content (MC). Delineation of these relationships is needed by design engineers to define the effect of CCA treatments on bending strength. Thus, the influence of short-term load duration and MC at test on the effect of CCA preservative treatments on strength are reported in this study.

43. Roof Temperatures in Simulated Attics

Winandy, Jerrold E.; Beaumont, Rhett
1995. *USDA Forest Serv. Res. Pap. FPL–RP–543.* 14 p.

In this study, five outdoor field exposure chambers were constructed near Madison, Wisconsin, in the summer of 1991. These structures were intended to simulate the attics of multifamily structures for which model building codes sometimes allow the use of fire-retardant-treated roof sheathing. Interior attic air, exterior air, inner and outer sheathing, and internal rafter temperature of black- and white-shingled chambers were monitored. This report presents actual roof temperature data from phase 1 of this experiment obtained from October 1, 1991, to September 30, 1994.

44. Practical Considerations of Dowel Bearing Strength and Annular Ring/Fastener Orientation

Winistorfer, Steve G.
1995. *Forest Prod. J.* 45(7/8): 64–68

This study originated from a research project in which connection tests were conducted to verify the yield model for nailed connections. This study describes the results of dowel-bearing tests that were conducted as part of that project.

Fiber and Particle Products

45. Biobased, Biodegradable Geotextiles: USDA Forest Service Research Update

English, Brent
1994. *In: Steiner, P.R., comp. Proceedings of the 2d Pacific Rim bio-based composites symposium*; 1994 November 6–9; Vancouver, Canada. Vancouver, B.C.: University of British Columbia: 204–212.

Fiber options for biobased geotextiles include coir, jute, kenaf, flax, sisal, hemp, cotton, and wood fiber. Biobased geotextiles are used for short-term applications where biodegradability is a positive attribute, such as mulch to increase plant growth and survival and control soil erosion; sheet mulch may be incorporated with seeds that will germinate and take over the soil stabilization role as the geotextile biodegrades. This paper presents a USDA Forest Service research update on biobased, biodegradable geotextiles.

46. Recent Developments in Annual Growth Lignocellulosics as Reinforcing Fillers in Thermoplastics

Jacobson, R.E.; Caulfield, D.F.; Rowell, R.M.; Sanadi, A.R.
1995. *In: Proceedings of 2d Biomass conference of the Americas: Energy, environment, agriculture, and industry*; 1995 August 21–24; Portland, OR. Golden, CO: National Renewable Energy Laboratory: 1171–1180.

Recent interest in reducing the environmental impact of materials is leading to the development of newer agricultural-based materials that can reduce the stress on the environment. This paper reports on recent developments in annual growth lignocellulosics as reinforcing fillers in thermoplastics.

47. United States Based Agricultural "Waste Products" as Fillers in a Polypropylene Homopolymer

Jacobson, Rodney E.; Rowell, Roger M.; Caulfield, Daniel F.; Sanadi, Anand R.

1995. In: Proceedings of 2d Biomass conference of the Americas: Energy, environment, agriculture, and industry; 1995 August 21–24; Portland, OR. Golden, CO: National Renewable Energy Laboratory: 1219–1227.

With the advent of modern coupling agents (MAPP or maleic anhydride grafted polypropylene), the potential use of various types of renewable, sustainable agricultural by-products as fillers in thermoplastics is explored. More than 7.7 billion pounds of fillers were used in the plastics industry in 1993. With sharp price increases in commodity thermoplastics, the amount of fillers in thermoplastic materials will increase throughout the 1990s. This paper reports on the mechanical properties of the 12 resultant composites and compares them to wood flour and talc-filled polypropylene composites.

48. Wood-Polymer Bonding in Extruded and Nonwoven Web Composite Panels

Krzysik, Andrzej M.; Youngquist, John A.; Myers, George E.; Chahyadi, Ichwan S.; Kolosick, Paul C.

1991. In: Conner, A.H.; Christiansen, A.W.; Myers, G.E. [and others], eds. Wood adhesives 1990: Proceedings of a symposium. Madison, WI: Forest Products Research Society: 183–189.

Promising technology is evolving for using waste or low grade wood blended with polyolefin plastics to make an array of high-performance reinforced composite products. This technology provides a strategy for producing advanced materials that take advantage of the enhanced properties of both wood and plastic. Advantages associated with these composite products include light-weight and improved acoustic, impact, and heat reformability properties. The research program outlined here focuses on extrusion and nonwoven web technology.

49. Bending and Twisting Tests for Measurement of the Stiffness of Corrugated Board

Luo, S.; Suhling, J.C.

1995. In: Perkins, Richard, ed. Mechanics of cellulosic materials –1995: Proceedings of 1995 joint ASME applied mechanics and materials meeting; 1995 June 28–30; Los Angeles. New York: The American Society of Mechanical Engineers: 91–109. AMD-Vol. 209/MD-Vol. 60.

In this study, an experimental procedure to measure the bending stiffnesses D_{11} , D_{22} , D_{12} , and D_{66} of an equivalent single-layer orthotropic plate representing a corrugated board panel is proposed. The technique includes standard four-point bending tests of beam specimens to assist in the evaluation of the stiffnesses D_{11} and D_{22} . In addition, special plate twisting tests are suggested for finding the stiffnesses D_{12} and D_{66} and the effective Poisson's ratios of the combined board.

50. Swelling of Wood. Part III. Effect of Temperature and Extractives on Rate and Maximum Swelling

Mantanis, George I.; Young, Raymond A.; Rowell, Roger M.

1995. *Holzforschung*. 49: 239–248.

The swelling of wood in water and organic liquids is of significant importance. Most previous work has been directed towards the extent of wood swelling at equilibrium. In this work, the rate of wood swelling was investigated and the effect of temperature as well as the effect of extractives on the rate and maximum swelling of wood were also ascertained.

51. Composites From Recycled Wood and Plastics

Youngquist, John A.; Myers, George E.; Muehl, James H.; Krzysik, Andrzej; Clemons, Craig M.

1994. Project Summary. Prepared for U.S. Environmental Protection Agency, Cincinnati, OH. 20 p.

The ultimate goal of this research was to develop technology to convert recycled wood fiber and plastics into durable products that are recyclable and otherwise environmentally friendly. Two processing technologies were used to prepare wood-plastic composites: air-laying and melt-blending.

Fire Safety

52. Fire Information Resources in the USDA Forest Service

Blankenburg, Julie

1994. In: Chong, Jean; Green, Janet, eds. Proceedings of 1994 annual fire conference; 1994 May 11–13; Fairfax, VA. Boston, MA: Society of Fire Protection Engineers: 70–79.

Various branches of the Forest Service generate fire information, but no single location provides all publications related to this area. This report describes the kinds of fire research conducted by the Forest Service and access to research publications through the FS INFO database. Distribution centers for research stations, the Washington Office, the Forest Products Laboratory, and the Northeastern Area are also listed.

53. Experimental and Analytical Protocol for Ignitability of Common Materials

Dietenberger, Mark A.

1995. *Fire Mater.* 19: 89–94.

In this study, a protocol was developed to increase accuracy, generality, and efficiency when determining piloted ignition properties.

54. Protocol for Ignitability, Lateral Flame Spread, and Heat Release Rate Using Lift Apparatus

Dietenberger, Mark A.

1995. In: Nelson, Gordon L., ed. Fire and polymers II. Materials and tests for hazard prevention: Proceedings of 208th National meeting of the American Chemical Society; 1994 August 21–26; Washington, DC. ACS symposium series 599. Washington, DC: American Chemical Society. 435–449. Chap. 29.

In this study, protocols in ASTM E 1321 for determining piloted ignition and flame spread properties and in E 1317 for deriving heat release rate are modified to improve generality, accuracy, and efficiency. New methods are reported that improve the calibration of radiative and convective heat flux profiles on the exposed material, such as Douglas-fir plywood.

55. Simplified Models for the Properties of Dimension Lumber and Metal-Plate Connections at Elevated Temperatures

Shrestha, D.; Cramer, S.; White, R.

1995. *Forest Prod. J.* 45(7/8): 35–42.

The objective of this paper was to introduce practical models to predict the response of dimension lumber and metal-plate joints exposed to pyrolytic temperatures. A new tool for the fire-endurance modeling of a wood truss resulted when these models were integrated with a structural analysis package.

56. Analytical Methods for Determining Fire Resistance of Timber Members

White, Robert H.

1995. In: The SFPE handbook of fire protection engineering. 2d ed. Boston, MA: Society of Fire Protection Engineers: 4-217–4-229. Chap. 11.

When attention is given to a detail, the fire endurance of a wood member or assembly depends on three items: (1) performance of its protective membrane (if any), (2) extent of charring of the structural wood element, and (3) load-carrying capacity of the remaining uncharred portions of the structural wood elements. This paper reviews the methods available to determine the contribution of each item and discusses the major properties of wood that affect the thermal and structural response of wood assemblies or components.

Microbial and Biochemical Technology

57. One-Electron Oxidation in the Degradation of Creosote Polycyclic Aromatic Hydrocarbons by *Phanerochaete Chrysosporium*

Bogan, Bill W.; Lamar, Richard T.

1995. *Appl. Environ. Microbiol.* 61(7): 2631–2635.

This paper reports the disappearances of three- to six-ring creosote polycyclic aromatic hydrocarbon (PAH) constituents from intact fungal

cultures and during lipid peroxidation *in vitro*. In each of these cases, the process is shown to be primarily dependent on ionization potential, implying that the participation of one or more one-electron oxidants is involved across the full range of PAHs tested. The possible nature of this oxidant is discussed.

58. Recent Advances in the Organization and Regulation of Lignin Peroxidase Genes of *Phanerochaete Chrysosporium*

Gaskell, Jill; Cullen, Daniel
1993. J. Biotechnol. 30: 109–114.

Lignin depolymerization is catalyzed by extracellular peroxidases of white-rot basidiomycetes, such as *Phanerochaete chrysosporium*. In submerged culture, production of multiple lignin peroxidase (LiP) isozymes is derepressed under carbon, nitrogen, or sulfur limitation. The roles of the individual isozymes in lignin degradation and their genetic regulation are poorly understood.

59. Mechanisms for Polycyclic Aromatic Hydrocarbon Degradation by Ligninolytic Fungi

Hammel, Kenneth E.
1995. Environmental Health Perspectives. 103(Suppl. 5): 41–43.

Ligninolytic fungi accomplish the partial degradation of numerous aromatic organopollutants. Their ability to degrade polycyclic aromatic hydrocarbons (PAHs) is particularly interesting because eukaryotes were previously considered to be unable to cleave fused-ring aromatics. Recent results indicate that extracellular peroxidases of these fungi are responsible for the initial oxidation of PAHs. Fungal lignin peroxidases oxidize certain PAHs directly, whereas fungal manganese peroxidases co-oxidize them indirectly during enzyme-mediated lipid peroxidation.

60. H₂O₂ Recycling During Oxidation of the Arylglycerol β -Aryl Ether Lignin Structure by Lignin Peroxidase and Glyoxal Oxidase

Hammel, Kenneth E.; Mozuch, Michael D.; Jensen, Kenneth A.; Kersten, Philip J.
1994. Biochemistry. 33: 13349–13354.

In this study, oxidative C _{α} –C _{β} cleavage of the arylglycerol β -aryl ether lignin model 1-(3,4-dimethoxyphenyl)-2-phenoxypropane-1,3-diol (I) by *Phanerochaete chrysosporium* lignin peroxidase in the presence of limiting H₂O₂ was enhanced four- to five-fold by glyoxal oxidase from the same fungus. Further investigation showed that each C _{α} –C _{β} cleavage reaction released 0.8–0.9 equiv of glycylaldehyde, a glyoxal oxidase substrate.

61. New Polymeric Model Substrates for the Study of Microbial Ligninolysis

Kawai, Shingo; Jensen, Jr., Kenneth A.; Bao, Wuli; Hammel, Kenneth E.
1995. Appl. Environ. Microbiol. 61(9): 3407–3414.

This paper reports the synthesis of polymeric models in which the major B–O–4-linked substructure of lignin is covalently attached to polyethylene glycol (PEG) or polystyrene (PS). By use of the frequently studied white-rot fungus *P. chrysosporium*, this study shows that the PEG-linked model can be used to detect ligninolytic reactions in defined medium cultures, in fungus-colonized wood, and *in vitro* with purified fungal LiP.

62. Use of Wood-Decay Fungi for Disposal of PCP-Treated Wood

Lamar, Richard T.
1995. In: The challenge—Safety and environment. Proceedings of the 3rd International wood preservation symposium; 1995 February 6–7; Cannes-Mandelieu, France. IRG/WP 95–50040. Stockholm, Sweden: IRG Secretariat: 442–449.

The objective of this study was to evaluate the effectiveness of a solid substrate fungal treatment for the removal of PCP from wood chips generated from PCP-treated utility poles. The study was conducted at the Twin Cities Army Ammunition Plant (TCAAP) located in New Brighton, Minnesota. Both Western Red Cedar and Southern Pine utility poles were included in the study.

63. Quantitation of Fungal mRNAs in Complex Substrates by Reverse Transcription PCR and Its Application to *Phanerochaete Chrysosporium*-Colonized Soil

Lamar, R.T.; Schoenike, B.; Vanden Wymelenberg, A.; Stewart, P.; Dietrich, D.M.; Cullen, D.
1995. Appl. Environ. Microbiol. 61(6): 2122–2126.

This paper reports on the development of generally applicable techniques for the quantitative assessment of specific mRNAs in soil. The approach is demonstrated with *P. chrysosporium* cultured on pentachlorophenol- (PCP-) contaminated soil. The transcript patterns observed are unlike those found in defined media. The results have important implications in defining the roles of specific genes in organopollutant degradation and in the development of strain improvement strategies.

Processing of Wood Products

64. Drying of Southern Pine Poles for Preservative Treatment

Boone, R. Sidney
1994. In: Proceedings 7314. Proceedings of the 1st southeastern pole conference; 1992 November 8–11; Starkville, MS. Madison, WI: Forest Products Society: 157–162.

Whether Southern Pine poles are destined for treatment with waterborne or oilborne wood preservatives, the majority of these poles are kiln dried prior to treatment. This paper reports observations from visits to 12 pole-drying operations in five states.

65. Effects of Redrying Schedule on Preservative Fixation and Strength of CCA-Treated Lumber

Boone, R. Sidney; Winandy, Jerrold E.; Fuller, James J.
1995. Forest Prod. J. 45(9): 65–73.

The objective of this exploratory study was to specifically relate the effect of seven post-treatment combinations of dry-bulb temperatures and wet-bulb depressions on CCA fixation to strength loss, aquatic leachability of the fixed preservative chemicals, and the bioefficacy of the redried treated products from CCA-treated Southern Pine and Western Hemlock lumber.

66. Modeling Prong Test Response During Conditioning of Red Oak Lumber

Fuller, James
1995. USDA Forest Serv. Res. Pap. FPL–RP–540. 7 p.

The objective of this study was to determine how the prong test response is altered during conditioning and how prong length and thickness influence the prong response. The approach used in this study was to record moisture content, strain distribution through the board, and prong test results during conditioning. Then, the predicted prong response, as dictated by the strain distribution, was compared with the actual prong response to gain a more thorough understanding of the influence of stress alterations.

67. Temperature Distribution in a Nailed Gypsum-Stud Connection Exposed to Fire

Fuller, James; Leichty, Robert; White, Robert
1994. In: Fridley, K.J.; Dolan, J.D., eds. Systems approach to wood structures. Proceedings of the Wood Engineering Division sessions at the 1993 annual meeting of the Forest Products Society; 1993 June 20–23; Clearwater Beach, FL. Proceedings 7312. Madison, WI: Forest Products Society: p. 63.

To determine the connection performance under elevated temperatures, information is needed about the mechanical properties and the temperature distribution of the connection along the nail that joins the gypsum panel to the stud. This report on the temperature distribution along the nail is one part of a three-part study concerned with connection performance.

68. Energy Criterion for Fatigue Strength of Wood Structural Members

Liu, Jen Y.; Ross, Robert J.
1995. In: Perkins, Richard, ed. Mechanics of cellulosic materials—1995—Proceedings of 1995 joint ASME applied mechanics and materials meeting; 1995 June 28–30; Los Angeles. New York: The American Society of Mechanical Engineers: 125–133. AMD-Vol. 209/MD-Vol. 60.

This report describes a mathematical model for fatigue strength of cellulosic materials under sinusoidal loading. The model is based on the Reiner-Weissenberg thermodynamic theory of strength in conjunction with a nonlinear Eyring's three-element model.

69. Review of Nondestructive Evaluation of Timber

Ross, Robert J.; Pellerin, Roy F.

1994. *In*: Technical aspects of maintaining, repairing, preserving historically significant ships: Proceedings of conference; 1994 September 12–14; Charlestown, MA. Washington, DC: Naval Historical Center: 78–91.

Nondestructive evaluation of materials, the science of identifying the physical and mechanical properties of materials without altering their end-use capabilities, is valuable in defining relationships between properties and performance of materials. A comprehensive report has been prepared that reviews nondestructive testing of wood research and application techniques. This paper provides a brief synopsis of that report and other pertinent research that has been published since completing the comprehensive report.

70. Stress Wave Techniques for Determining Quality of Dimensional Lumber From Switch Ties

Schad, Kristin C.; Kretschmann, David E.; McDonald, Kent A.; Ross, Robert J.; Green, David W.

1995. USDA Forest Serv. Res. Note FPL–RN–0265. 12 p.

Researchers at the Forest Products Laboratory, USDA Forest Service, have been studying nondestructive techniques for evaluating the strength of wood. This report describes the results of a pilot study on using these techniques to determine the quality of large dimensional lumber cut from switch ties.

Pulp, Paper, and Packaging

71. Recyclability of Linerless PSA Stamps

Abubakr, Said; Bormett, David W.; Klungness, John H.; Fatah, Alim A.; Stagg, Timothy V. Moy, Dart S.; Scott, Gary M.; Ross-Sutherland, Nancy; Kumar, Rajendra; LaBrosse, Paul R.

1995. *In*: Proceedings of the 1995 TAPPI Pulping conference; 1995 October 1–5; Chicago, IL. Atlanta, GA: TAPPI PRESS: 109–114. Book 1.

This study established pilot-scale separation sequences for assessing the recyclability of postage stamp material. Tests involved preparation and processing of paper stock and measurement of contaminants during processing.

72. Raman Spectroscopy

Agarwal, Umesh P.; Atalla, Rajai H.

1995. *In*: Connors, Terrance E.; Banerjee, Sukit, eds. Surface analysis of paper. Boca Raton, FL: CRC Press, Inc.: 152–181. Chap. 8.

This chapter discusses Raman spectroscopy and its application in pulp and paper research.

73. Sequential Treatment of Mechanical and Chemimechanical Pulps With Light and Heat: A Raman Spectroscopic Study

Agarwal, Umesh P.; Atalla, Rajai H.; Forsskahl, Ingegerd

1995. *Holzforschung*. 49: 300–312.

The results of this study clearly show that Raman spectroscopy can be used advantageously to study changes in pulps caused by chemimechanical pulping, peroxide bleaching, and treatments of light and heat.

74. Using Simons Stain to Predict Energy Savings During Biomechanical Pulping

Akhtar, Masood; Blanchette, Robert A.; Burnes, Todd A.

1995. *Wood Fiber Sci.* 27(3): 258–264.

Pretreatment of wood chips with lignin-degrading fungi can save substantial amounts of electrical energy during a mechanical pulping process. To optimize this process, a rapid and reliable method was needed to predict energy savings. This study examined a fiber staining method that involves the use of Simons stain. This stain for microscopic examination of pulp

fibers was used previously to evaluate the degree of fibrillation in beaten fibers or more recently to differentiate fibers from untreated and fungus-treated wood chips.

75. Cellulose and the Hemicelluloses: Patterns for Cell Wall Architecture and the Assembly of Lignin

Atalla, R. H.

1995. *In*: Proceedings of the 8th international symposium on wood and pulping chemistry; 1995 June 6–9; Helsinki, Finland. [Espoo, Finland: KCL]: 77–84. Vol. 1.

This paper discusses some reasons for seeking a new paradigm and to propose an alternative model for the assembly of the cell wall. The model is one that could account for the diversity of molecular architecture observed in cell walls at the nanoscale level, while allowing a level of detail in the control of structure by the organism beyond that envisioned, and more consistent with the general pattern in biological systems. It can also provide a logical framework for any efforts to accomplish genetic modifications of woody species.

76. Semiannual Conferences Review—July–December 1994

Borchardt, John K.; Scott, Gary M.; Doshi, Mahendra R.

1995. *Prog. in Pap. Recycl.* 4(2): 89–102.

This paper provides a review of the material presented at five conferences related to recycling. Papers reviewed contain both fundamental and practical information to satisfy the needs of practitioners and academicians.

77. Removal of Hot-Melt Adhesives With Through-Flow Cleaners

Bormett, David W.; Lebow, Patricia K.; Ross, Nancy J.; Klungness, John H.

1995. *Tappi J.* 78(8): 179–184.

The objective of this study was to investigate the relationship between hot-melt adhesive density and through-flow cleaner removal efficiency. Through-flow cleaners are hydrocyclones designed to remove lightweight contaminants from pulp slurries.

78. Semiannual Conference Review—January–June 1995

Doshi, Mahendra R.; Scott, Gary M.; Borchardt, John K.

1995. *Prog. in Pap. Recycl.* August: 79–93.

This review summarizes recycling-related articles presented at six conferences. Two of the six conferences, TAPPI Recycling Symposium and Wastepaper VI, were devoted solely to paper recycling. The other four conferences were of much broader scope and included paper recycling as a part of the program because of its importance.

79. Recycling Research Progress at the Forest Products Laboratory

Forest Products Laboratory.

1995. USDA Forest Serv. Gen. Tech. Rep. FPL–GTR–86. 19 p.

This document summarizes accomplishments of USDA Forest Service researchers in the area of recycling. Specifically, it describes work in economic assessment, paper recycling, recycled housing and industrial applications of recycled materials, other recycling applications, and technology transfer. The literature list includes the references cited in the text and additional publications regarding Forest Service recycling research.

80. Industrial Scale-up of Enzyme Enhanced Deinking of Non-Impact Printed Toners

Heise, Oliver U.; Fineran, William G., Jr.; Unwin, Jay P.; Sykes, Marguerite; Klungness, John H.; Abubakr, Said

1995. *In*: Proceedings of the 1995 TAPPI Pulping conference; 1995 October 1–5; Chicago, IL. Atlanta, GA: TAPPI PRESS: 349–354. Book 1.

This paper presents the results of an industrial-scale investigation exploring the benefits of enzyme-enhanced deinking. Because residual toner inks are the primary contaminant remaining in deinked marked pulp, 100 percent laser-printed white office wastepaper was used for these trials. The results of three deinking trials—two enzyme trials and a control—are presented in this paper.

81. 3-D Fiber Forming—A Step Toward Engineered Sandwich Construction

Hunt, J.F.; Noble, R.L.; Smyrski, R.M.

1995. In: Allen, Howard G., ed. Pre-prints, 3d International conference on sandwich construction; 1995 September 12–15; Southampton, UK: Vol. 1, Sessions 1–6. 9 p.

Two fiber-forming methods have been developed that can form fibers into a three-dimensional (3-D) ribbed matrix. This forming process can use wood-fibers, virgin and recycled, or most any cellulose or synthetic fiber to form a 3-D matrix. This paper discusses the forming process, some unique capabilities of this process, and present strength properties of wood-fiber and preliminary wood-fiber/fiberglass-fiber structures made using prototype molds.

82. Reaction of *p*-Hydroxycinnamyl Alcohols With Transition Metal Salts. 1. Oligolignols and Polyolignols (DHPs) From Coniferyl Alcohol

Landucci, Lawrence L.

1995. *J. Wood Chem. Tech.* 15(3): 349–368.

This report, the first in a series, deals mainly with the scope and flexibility of reactions of coniferyl alcohol with salts of iron, manganese, and cobalt to produce a variety of oligolignols and polyolignols.

83. Analysis of Plant Cell Walls—Session Synopsis

Obst, John R.

1993. *Forage Cell Wall Structure and Digestibility*. Chapter 7.

In this chapter, the distribution and composition of lignin, primarily in wood tissue, are reviewed.

84. Performance of Enzymatically Deinked Wastepaper on Paper Machine Runnability

Rutledge-Cropey, Kathie; Klunness, John H.; Abubakr, Said M.

1995. In: Proceedings of the 1995 TAPPI Pulping conference; 1995 October 1–5; Chicago, IL. Atlanta, GA: TAPPI PRESS: 639–643. Book 2.

The process of enzymatic deinking has been proven to be an effective method for removing noncontact inks from wastepaper. A secondary effect of enzyme treatment is enhanced pulp drainage. This study investigated the effects of enzymatic deinking on paper machine runnability, specifically drainage and wet-web strength enhancement.

85. Recyclability of New Postage Stamp Material

Scott, Gary M.; Bormett, David W.; Lebow, Patricia; Ross–Sutherland, Nancy; Klunness, John H.; Abubakr, Said; Fatah, Alim A.; Kumar, Rajendra

1995. In: Proceedings of the joint conference covering environmental benign pressure sensitive adhesives for postal application; 1995 February 14; Windsor Lock, CT. Enfield, CT: Springborn Laboratories, Inc.: B 7-1–B 7-21.

This work was an initial study into the efficacy of current technology to remove those contaminants that are present in postage stamp materials.

86. Fungal Pretreatment of Wood Chips for Sulfite Pulping

Scott, Gary M.; Akhtar, Masood; Lentz, Michael

1995. In: Proceedings of the 1995 TAPPI Pulping conference; 1995 October 1–5; Chicago, IL. Atlanta, GA: TAPPI PRESS: 355–361. Book 1.

In this study, the effect of fungal pretreatment of loblolly pine chips *Pinus taeda* prior to sodium- and calcium-based sulfite pulping was examined. The pretreatment involved a 2-week incubation of the chips with two strains of the white-rot fungus *Ceriporiopsis subvermisporea*. Focus was on the kappa number, yield, and liquor consumption.

87. Environmental Aspects of Biosulfite Pulping

Scott, Gary M.; Lentz, Michael; Sykes, Marguerite; Abubakr, Said

1995. In: Proceedings of 1995 International environmental conference; 1995 May 7–10; Atlanta, GA. Atlanta, GA: TAPPI PRESS: 1155–1161. Book 2.

In this study, the effect of fungal pretreatment of wood chips prior to sodium- and calcium-based sulfite pulping was examined. The pretreatment

involved a 2-week incubation of loblolly pine chips with two strains of the white-rot fungus *Ceriporiopsis subvermisporea*. Focus was on the kappa number and yield, effluent quality, and pulp bleachability after pulping.

88. Formation and Structure of Lignified Plant Cell Wall—Factors Controlling Lignin Structure During its Formation

Terashima, Noritsugu; Atalla Rajai H

1995. In: Proceedings of the 8th International symposium on wood and pulping chemistry; 1995 June 6–9; Helsinki, Finland. [Espoo, Finland: KCL]:69–76. Vol. 1.

Lignin is formed by polymerization of monolignols within a polysaccharide matrix; therefore, it is anticipated that the structure of the polyolignol will depend on reaction conditions with the microenvironments provided by the polysaccharide constituents. Within this context, this study clearly points to the likely effects of pH and matrix polarity on the distribution of inter unit linkages between the monolignols. It is also quite likely that association of the oligomers with polysaccharide matrix constituents will have a significant effect.

89. Polyoxometalate Bleaching: A Highly Selective, Closed-Mill Technology

Weinstock, I.A.; Atalla, R.H.; Reiner, R.S.; Hill, C.L.; Houtman, C.J.

1995. In: Proceedings of 1995 International environmental conference; 1995 May 7–10; Atlanta, GA. Atlanta, GA: TAPPI PRESS: 1197–1199. Book 2.

Polyoxometalates, a class of oxidatively robust inorganic oxidants and oxidation catalysts, are currently under investigation at the Forest Products Laboratory and at Emory University as an alternative to chlorine-based chemicals in the bleaching of softwood kraft and other pulps. The goal of ongoing research is to develop a highly selective, energy-efficient, oxygen-based polyoxometalate delignification and bleaching technology, compatible with mill closure.

90. Highly Selective Oxidative Delignification of Kraft Pulp by Water Soluble Polyoxometalates

Weinstock, Ira A.; Atalla, Rajai H.; Hill, Craig L.; Reiner, Richard S.; Houtman, Carl J.

1995. In: Proceedings of the 8th international symposium on wood and pulping chemistry; 1995 June 6–9; Helsinki, Finland. [Espoo, Finland: KCL]: 469–376. Vol. 1.

This study demonstrated the feasibility of using polyoxometalate salts and oxygen in the commercial bleaching of chemical pulps. The goal of this ongoing research and development effort is to develop a highly selective, oxygen-based polyoxometalate delignification and bleaching technology compatible with mill closure.

91. Polyoxometalate Bleaching of Kraft Pulp: A Highly Selective Closed Mill Technology

Weinstock, I.A.; Atalla, R.H.; Reiner, R.S.; Moen, M.A.; Hammel, K.E.; Hill, C.L.; Houtman, C.J.

1995. In: Proceedings of the 1995 TAPPI Pulping conference; 1995 October 1–5; Chicago, IL. Atlanta, GA: TAPPI PRESS: 153–156. Book 1.

Data presented here demonstrate that polyoxometalate complexes are able to (1) selectively delignify unbleached kraft pulps to low kappa numbers and (2) facilitate the complete wet oxidation of dissolved lignin fragments to carbon dioxide and water.

92. Mechanism of Action of Simons' Stain

Yu, Xiaochun; Minor, James L.; Atalla, Rajai H.

1995. *Tappi J.* 78(6): 175–180.

Recently, researchers used Simons' stain to examine the effect of pre-bleaching kraft pulps with enzymes. Because the enzyme treatment produced a change in the pulp that was detectable by the stain, interest in verifying the physical significance of that change was heightened. In the present study, the Jayme and Harders-Steinhauser mechanism was tested and verified. Based on this mechanism, a modification for Simons' stain is suggested.

Timber Demand and Technology Assessment

93. National Forests of Wisconsin: Demographics and Recreation Participation

Alig, Joanne T.; Voss, Paul R.

1995. USDA Forest Serv. Res. Pap. FPL-RP-542. 14 p.

This study used data from the 1990 U.S. Census to examine changes in the human population surrounding the Chequamegon and Nicolet National Forests in Wisconsin. A methodology was then developed to project future participation in recreation on those national forests based solely on demographics. This research highlights the difficulties inherent in making point-in-time estimates or forecasts of recreation participation for a specific location, such as a national forest.

94. Recovery of Paper and Wood for Recycling: Actual and Potential

Ince, Peter J.; McKeever, David B.

1995. USDA Forest Serv. Gen. Tech. Rep. FPL-GTR-88. 11 p.

In this paper, quantities of paper and wood recovered annually for recycling were estimated for all principal commercial uses in the United States, based on material consumption and end-use data. Principal categories of commercial uses were identified and relative quantities were compared. Some innovative or novel commercial product developments were identified.

95. Wastepaper Recycling and the Future Timber Market

Ince, Peter J.; Alig, Joanne T.

1992. In: Agriculture outlook '92—New opportunities for agriculture: Proceedings of 68th annual outlook conference; 1991 December 3-5; Washington, DC. Washington, DC: World Agricultural Outlook Board: 180-188. Vol. 2.

This report presents information on likely rates of wastepaper recycling in the late 1990s by product grade and show the anticipated timber market consequences in terms of regional timber consumption and prices.

96. Recycling in the Big Picture—The Really Big Picture

Ince, Peter J.; Skog, Kenneth E.; Heath, Linda S.

1995. Resour. Recycl. 14(6): 41-45.

Recent research at the USDA Forest Service, Forest Products Laboratory, found that 10 to 20 percent of the U.S. carbon reduction goal could be met through a range of scenarios for paper and wood recycling. This paper explains and discusses some of these scenarios.

97. Resource Potential of Wood-Based Wastes in the United States

McKeever, David B.

1995. In: Proceedings of 2d Biomass conference of the Americas: Energy, environment, agriculture, and industry; 1995 August 21-24; Portland, OR. Golden, CO: National Renewable Energy Laboratory: 77-87.

In this report, total amounts of waste generated, wood waste generated by type, and wood waste potentially available for recycling are quantified for each source of waste. Estimates are based on published waste generation volumes and rates, measures of economic activity, and trends in virgin wood use in specific markets. The report also identifies possible uses for each source of wood waste and includes recommendations for better utilizing this resource.

98. Capacity Changes in U.S. Particleboard, Southern Pine Plywood, and Oriented Strandboard Industries

Spelter, Henry

1995. Can. J. For. Res. 25: 614-620.

This paper focuses on the capacity change component of supply. Specifically, empirical results are presented for three sectors of the forest products industry: particleboard, oriented strandboard, and Southern Pine plywood. First, previous work and experiences with capacity change models are reviewed. Second, the empirical model is developed. Third, the industries and the data used are described. Finally, the results are presented and discussed.

Tropical Wood Utilization

99. Laboratory Test for Grouping Tropical Species for Kiln Drying

Mendes, A. de Souza; Simpson, W.T.; Verrill, S.P.

1995. Wood Sci. Technol. 29: 353-362.

Industrial wood drying presently requires a large amount of wood of the same species to be practical. The heterogeneity of the Amazonian forest makes it almost impossible to continuously supply the amount of wood required for kiln drying with just one species. The objective of this research was to develop a laboratory test for grouping tropical hardwoods for drying, based on similar drying times.

Wood Bonding Systems

100. Size Exclusion Chromatography of Cellulose and Cellulose Derivatives

Conner, Anthony H.

1995. In: Wu, Chi-san, ed. Handbook of size exclusion chromatography. Chromatographic Science Series. 69: 331-352. New York: Marcel Dekker, Inc. Chapter 13.

Size exclusion chromatography (SEC) has been and will continue to be an important tool in the characterization and analysis of cellulose and cellulose derivatives. The SEC analysis of cellulose was reviewed in 1975 and covered the literature through about 1972. This review covers the literature from about 1970 to 1991 and may overlap with the previously reviewed literature.

101. The Effects of Temperature and Humidity on Phenol-Formaldehyde Resin Bonding

Wang, X.-M.; Riedl, B.; Christiansen, A.W.; Geimer, R.L.

1995. Wood Sci. Technol. 29: 253-266.

In this study, lap-shear joints were bonded in an environment of controlled temperature and relative humidity for a preselected range of pressing times. The phenol-formaldehyde bonded specimens were tested in tensile shear at room temperature and the results were used to construct bond strength development curves. In addition, the rate of bond strength development at each relative humidity was used for the evaluation of bonding kinetics.

Special Item

Selection and Use of Preservative-Treated Wood

Cassens, D.; Feist, W.C.; Johnson, B.R.; De Groot, R.C.

1995. Forest Products Society, Madison, WI.

Available from Forest Products Society, 2801 Marshall Court, Madison, WI 53705-2295; (608) 231-1361. Cost: \$24.95.

This book provides a discussion of the causes and types of wood deterioration, the degree of protection needed in various applications, and the types of preservative systems available. Also covered in this book are material and treatment specifications, post-construction inspections, remedial treatments, finishing of treated wood, and safety and environmental issues. Information is supplied for specific applications of treated wood from playground structures to permanent wood foundations, and a comprehensive list of sources of information on treated wood is provided.

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